

Competitive Market Structures in Electricity

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Introduction

The publication of the California Public Utilities Commission's "Blue Book" on April 20, 1994, greatly stimulated the debate about competitive electricity market structures. In the Blue Book, the California PUC asked if the present market structures were adequate to support direct access for all customers in California, and if not, what changes would be required. In the five months since then, several alternative market models have been developed, drawing on experiences in both the United States and around the world, and these models are now being debated throughout California. Forums for these discussions include the PUC hearings, filings, and testimony, and in ad hoc working groups, such as the Competitive Power Market Working Group, which was initiated through the efforts of San Diego Gas and Electric Company.

While the following presentation draws on some of the work presented and discussed at meetings of the Competitive Power Market Working Group, the views presented here are solely my own.

Background

In the following discussion, each of the representative electric power markets are assumed to be extended from the generators through to the end use customers, effecting direct access. To proceed, let's first establish a set of working definitions:

Direct Access - direct access refers to the ability of the end-use customer to directly contract for its supply of electric power. It does not necessarily include the need to make any arrangements for either the scheduling of the power, nor for the scheduling of the use of the transmission service.

Retail Wheeling - retail wheeling, as it is conventionally defined, contemplates that the end-use customer contracts for both his supply of electric power as well as the transmission system use needed to deliver his power from his supplier to his facility. Such transmission system arrangements could involve contracts with several different utilities, each of which employed a different pricing methodology, terms and conditions, and curtailment provisions. Further, such transmission service arrangements typically involve the "scheduling" of the use of the transmission system with each of the wheeling utilities and system operators.

Transmission System Operator (TSO) - the operator of the transmission system for a control area (region encompassing several electric utility transmission systems), who is responsible for ensuring that the loads and generation within the control area are balanced constantly, and who monitors and manages loadings on the transmission facilities (through the redispatch of generation) to ensure that loadings remain within transmission facility rating limits.

Rebalancing - the process of balancing generation constantly to match load within the

control area, to ensure that system electrical frequency is maintained

Settlement - the process of pricing out the rebalancing costs, and allocating those costs to the parties which created the imbalances in the control area (mismatches between a customer's actual generation and his actual facility load, which difference was supplied/absorbed by another generator/customer).

In addition to these definitions, there are of course the electrical facts of life:

1. the generation in a control area must be constantly balanced with the load in the control area to within national standards if system frequency is to be maintained. These standards are established by the North American Electric Reliability Council (NERC), and are adhered to by all control areas in the US and Canada.
2. electrical power flows over the path of least resistance (actually, least impedance), in spite of our best efforts to define contract paths over which it is supposed to flow. Power which flows where it is not supposed to is called loop flow or unscheduled flow, and must be dealt with in daily operation.
3. loop flow imposes constraints on economic dispatch which must be addressed through redispatch, resulting in sub-optimal dispatch of the system, and the transfer of inefficiency costs from one party to another.
4. low load conditions, called minimum load conditions, exist when the minimum outputs levels of costly generation which must remain on-line at night (to serve the next day's load) together with the economically efficient power which could be produced by or delivered into a region exceed the system load. These conditions typically occur at night, and when they occur, the only solution is to reduce the use of the less costly energy, rather than incur additional costs by turning higher cost units off at night, then restarting them in the morning. This redispatch can transfer inefficiency costs from one party to another when the parties have rights to different generation.

Model Descriptions

For the purpose of this discussion, three models will be described, representing a range of possible electric power market models. At the present state of the market model discussion, these three models seem to represent the extreme ranges of the models, with the other alternatives falling between these models. Attachment 1 illustrates the three models for a simple contractual transaction between a single supplier and a single customer, illustrating the information exchange required to effect the transaction through the system, and to balance the contract. Attachment 2 presents in tabular form a comparison of some key features of the models.

Wheeling Model

This model is the closest to the present industry structure. It is based on contracts through the present utility systems, and contemplates no pooling activities within the model itself. In this model, the utility is the TSO. A customer would contract directly with a supplier

for his power supply, and would contract with individual utilities for both transmission and distribution retail wheeling service for delivery of the power from the supplier through the systems to the customer's premises. Under this system, the supplier would be responsible for adjusting his power production frequently, even continuously, to match the customer's load. The adjustment could be provided automatically through "automatic generation control", or AGC, linked directly to the customer's load, or less dynamically through adjustments scheduled or coordinated through the TSO's computer systems at time intervals ranging from 10 minutes to 60 minutes. The supplier would also be responsible for providing (or purchasing) control area services, such as back up power supplies (to cover the times when the primary supply generator is unavailable), voltage support (if needed by the transmission or distribution systems), and other ancillary control area services. Finally, recognizing that even the best control systems will occasionally fail to perform properly, the supplier would be responsible for settling with the TSO for any rebalancing power which was required by the supplier/customer.

While this type of transaction is currently done within the wholesale electric power market, the complexities of this kind of transaction are self-evident. For instance, this model assumes that the TSO has control over an adequate amount of generation to be able to provide the rebalancing services which are not provided by the suppliers themselves, and to ensure reliable system operation. For the most part, the parties who currently enter into these kinds of transactions represent substantial loads (such as municipal utilities), and control their own generation portfolios. Furthermore, the bulk of these transactions are scheduled between utility control areas, each of whom are constantly balancing their generation with their loads, and these schedules are typically held constant for an hour at a time or more (such as for block power sales).

To manage these transactions, the TSO will likely require the parties to provide a generation production schedule together with an hourly load forecast, and to arrange the transmission delivery schedule as well. Furthermore, during the day, the supplier will be expected to readjust the production schedule in order to match the customer's load and so advise the TSO. The TSO will be responsible for managing the transmission delivery system, and for redispatching generation to relieve any constraints on the transmission system. To do this, the TSO must either have generation of its own (such as would be the case during a transition to direct access), or have the ability to dispatch the generation of one or more of the suppliers, at some contract based cost.

To balance the costs at the end of each day, the TSO (or some other agency) would have to compare for each hour the scheduled delivery with the actual delivery, the scheduled consumption (load) with the actual consumption, and determine the prices at which power was redispatched at both the supply location and the load location. The net imbalances between schedules and actuals at each location times the redispatch prices represent the settlement charges to the parties. This rebalancing and settlement process would likely have to be done on at least an hourly interval, although the actual computations could be performed at the end of the month.

This market model would probably work for some limited number of transactions on a relatively unconstrained system, but would begin to strain when the number of transactions which had to be monitored by and noticed to the TSO began to increase, and when the system began to experience constraints due to either transmission limits or minimum load conditions.

Both of these constraint "opportunities" challenge the abilities of this market model to equitably allocate the costs of redispatch so as to minimize cost shifting between customers. Furthermore, with each supplier being responsible for the primary dispatch of his own portfolio of generation, the overall production and delivery of power would be substantially less efficient than the present centrally economically dispatched power grid until secondary developed through which the suppliers or customers could buy and sell power between themselves in order to achieve an efficient hourly dispatch.

Finally, without the development of such a secondary power market, there would be no vehicle through which the customers or the suppliers could see the market price of power, and thus could make intelligent purchase or sale decisions.

Pooled Bilateral Contract OPCO Model

In order to reduce the complexities of acquiring transmission between suppliers and direct access customers, and to enhance the potential for increased operational efficiency, the pooled bilateral transaction model, called OPCO, has been conceived. The OPCO model contemplates that several transmission owning utilities will pool their bulk power transmission systems together, and turn over operation of the pooled transmission system to an independent transmission system operator (TSO). TSO independence from the generation would assure operation of the system with indifference to whose power is being delivered or dispatched.

Under this OPCO model, customers contract directly with suppliers for their power supplies. Customers and/or suppliers would arrange with OPCO for delivery of their power through the bulk power transmission system and through their local distribution utility for local delivery.

As in the Wheeling Model, suppliers could elect to provide a delivery schedule to the TSO, together with a load forecast, or the supplier could elect to offer his generation to the TSO for "flexible" dispatch, meaning that the TSO would determine the level of generation required based on the economic order of the generation offers. If a supplier elected to provide a delivery schedule, he would then be obliged to monitor his customer's load, and, if necessary, to periodically adjust his delivery schedule and advise the TSO of the changes. As in the Wheeling Model, if the supplier decided to provide a delivery schedule and a load forecast, the TSO would then monitor the scheduled and actual deliveries and consumption, determine the rebalancing costs, and allocate the costs to the responsible parties through the settlement process.

However, unlike the Wheeling Model, with the OPCO model, if any generation is offered to the TSO as flexible, then the price of the generation dispatched by the TSO would represent a market price for power at that location, and would become the basis for the settlement system, and the supplier is relieved of the responsibility of adjusting his production to match his customer's load. Under OPCO, market prices would be developed for use by the settlement system, rather than contract prices. As the portion of generation which is offered as flexible increases toward 100% of the generation being operated, the market place will become more efficient, and the dispatch will become economically efficient, to the benefit of all the market participants.

The OPCO model provides operational simplification to the supplier and to the customer, reducing the amount of information they need to exchange constantly to meet the system.

performance requirements. OPCO also provides spot market prices which can be made available to all market participants, enhancing market visibility and better transaction decisions. Furthermore, OPCO could provide the means, through the bid-in flexible generator system, to price ancillary services such as backup power and voltage support, or it could leave it to the supplier to arrange independently.

OPCO has some potential for ensuring equity in the administration of transmission system constraints and minimum load constraints, to the extent that suppliers offer their power for flexible dispatch. However, to the extent that supplies are scheduled into the system, the potential for cost shifting due to transmission constraints and minimum load conditions will remain, as in the Wheeling Model.

POOLCO Model

The POOLCO Model contemplates pooling of the bulk power transmission systems of several utilities (the more inclusive the transmission system, the greater the operational efficiency which can be achieved), an independent TSO to operate the pooled transmission systems and to operate the spot power market and perform the generation dispatch, and a settlement system. In POOLCO, customers would acquire their power needs from any supplier through contracts which prescribe the price of the power, the delivery conditions (firm, interruptible), etc. Under POOLCO, however, it is intended that most generation would be offered into the system as flexible, and that generation would be dispatched by the TSO based on the offered prices, creating a deep spot market. This spot market would become the reference price at which power was delivered out of the POOLCO to customers, and would be the basis for power delivered to customers which was not covered by a bilateral contract between a customer and supplier. The bilateral contacts between suppliers and customers are written as swap contracts or contracts for differences which replace the spot market price with the contract price. The spot market price would therefore be used only to settle the imbalances between the amount of power actually delivered by the supplier and the customer's actual load. There would be no need for the supplier to provide a delivery schedule, as this would be determined by the TSO based on economics, nor to provide a load forecast, although variants of this model certainly include the ability of customers to bid prices at which they would be willing to curtail their loads. Thus, the entire production of a supplier becomes the imbalance which is credited at the local spot market price, and the entire consumption of the customer becomes the imbalance which is priced at the local spot market price. This simplifies the monitoring and settlement systems compared to either the OPCO or Wheeling Model.

Under POOLCO, assuming that most generation is offered as flexible, the dispatch will approach the equivalent of central economic dispatch for all pool participants. Furthermore, when constraints occur on the system, the TSO would be able to redispatch to relieve the constraint without regard to which parties received the allocations of remaining transmission or power deliveries. This redispatch would be performed based on economics, and the local spot market prices at the ends of the constraint would change accordingly. There would be no cost shifting under this type of redispatch, although costs would certainly change. The transmission rights of individual parties would determine who bears the cost of this redispatch.

With POOLCO, backup supplies and service reliability to the customers are assured

through the TSO's dispatch of all flexible generation. Spinning reserve, voltage support, and other control area services would be purchased on behalf of all customers by the TSO from the suppliers on a bid basis, providing the opportunity to use market forces to keep prices as low as possible, and the costs would be automatically and equitably allocated to all customers through the local spot market prices at the customer locations. There would be no opportunity to escape from these legitimate operational costs, nor to achieve windfall proceeds for providing them.

Summary

These three alternative market models are representative of the models being considered in the California industry restructuring efforts. These models range from the straightforward extension of the current utility-to-utility Wheeling Model, to OPCO, a partially pooled bilateral contract model, to POOLCO, a fully pooled model, all three of which support bilateral contracts and direct access. Each model has its respective supporters, and its perceived benefits and deficiencies.

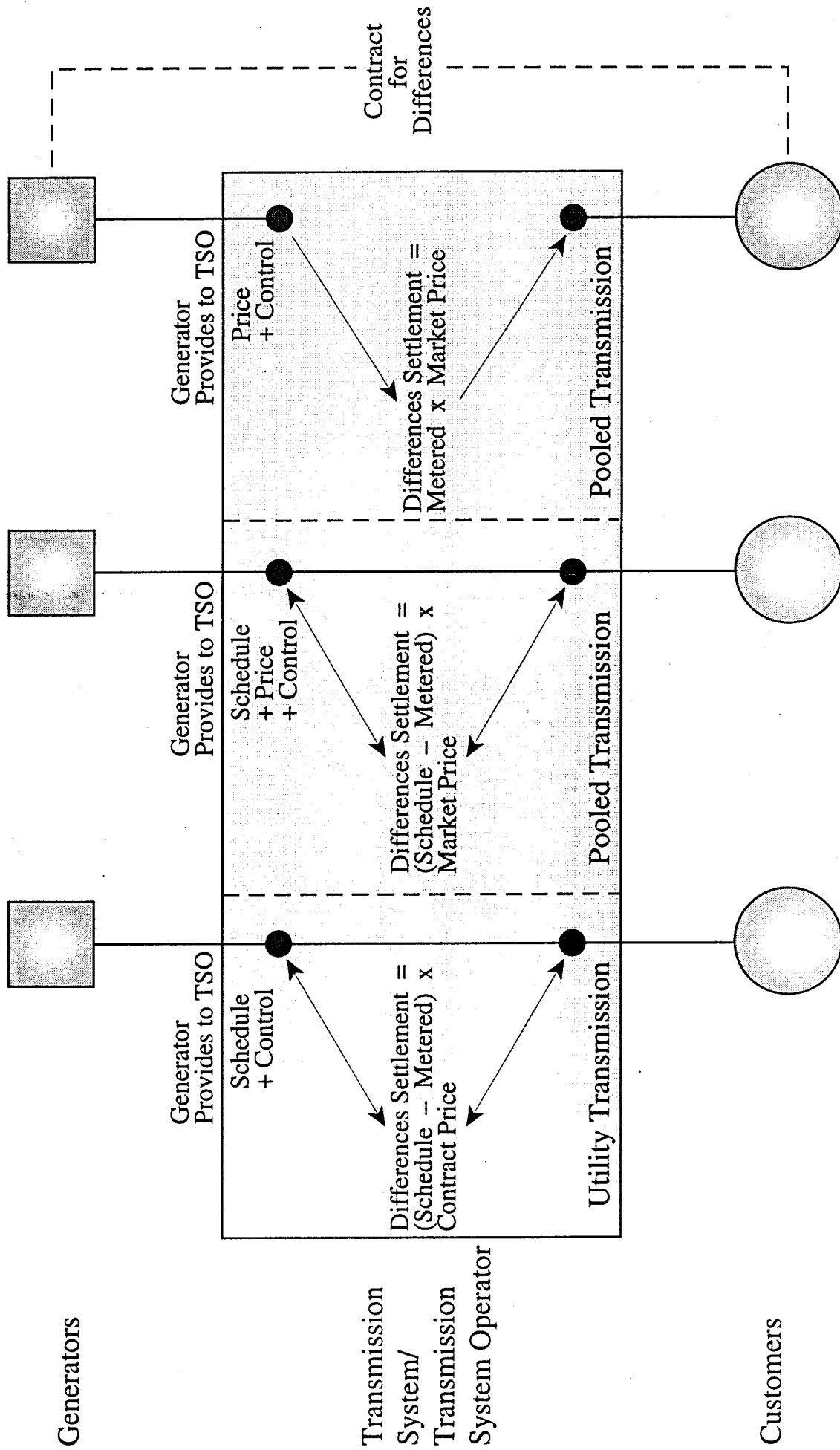
The Wheeling Model is perhaps both the best understood and at the same time the most misunderstood, as it appears to be straightforward continuance of a practice which the industry knows how to do. It also has some external appearances which are similar to the gas industry. However, in its details it is apparent that the Wheeling Model is incomplete, and that it will require development of a robust secondary wholesale power market to reach the dispatch efficiencies which are already present in the utility central dispatch model.

The OPCO model has some of the benefits of pooling, while retaining some of the familiarities of the Wheeling Model. Thus, OPCO partially solves some of the problems inherent in the Wheeling Model, and thus may be more capable of supporting direct access for a greater percentage of the customers, however it fails to fully deal with some of the equity problems created by transmission constraints and minimum load conditions.

The POOLCO model is a fully pooled model, supporting a fully functioning spot power market. POOLCO appears to provide all the contracting benefits of the Wheeling Model, with simpler requirements for both suppliers and customers, while achieving equitable solutions to several of the tougher operational dispatch problems such as transmission constraints and minimum load constraints. Furthermore, POOLCO represents a stable end-state model, in that it could accommodate 10 or 10 million transactions through it with no significant changes required in the basic market model. Finally, if POOLCO is implemented over a large region, such as the Western Systems Coordinating Council, it would provide enhanced operational efficiency through its central economic dispatch which would be unmatched by the other two models.

While the California debate has certainly stimulated discussion of alternative market models, it is clear that if long lasting benefits are to be achieved by the introduction of competition and direct access into the electric power industry, the design and development of a marketplace will have to be robust in the face of change, equitable to all participants, and encourage competition and produce real reductions in the cost of power. The challenge in the California debate will be to balance the urgency to do something now with the necessity to do the right thing for the longer future. We will live for many tomorrow's with the results of our actions today.

Similarities and Differences Between Market Systems



Wheeling Model

Physical schedules
Contract prices for settlement

OPCO Model

Physical schedules
Market prices for settlement

POOLCO Model

Market prices for settlement
Contracts for prices/terms

COMPARING ALTERNATIVE MARKET MODELS (page 1 of 2)			
	Wheeling Model	Pooled Bilateral Opco Model	Poolco Model
System Operator (TSO) Required	Yes	Yes	Yes
TSO Independence	No	Yes	Yes
TSO Dispatch of Flexible Plants	TSO's Own Plants	Few Plants Flexible	Most Plants Flexible
Quantity Nominations	All Plants & All Contracts	All Plants & All Contracts	All Plants
Reservation Price Bids	NA	For Flexible Plants	For Flexible Plants
Balancing Charges for Power	Specified in Bilateral Contract	Spot Prices	Spot Prices
Ancillary Service Charges Included (how based)	Specified in Bilateral Contract	Yes Average or by Location	Yes Average or by Location
Provides Tradeable Transmission Rights	Possible	Yes	Yes
Balancing and Settlements Based On:	Loads and Generation Net of Contract Nominations	Loads and Generation Net of Contract Nominations	Gross Loads and Generation
Allows Commercial Bilateral Contracts	Yes	Yes	Yes
Requires Interconnection Agreements to Utilities Outside Market	Yes	Yes	Yes

COMPARING ALTERNATIVE MARKET MODELS - (page 2 of 2)

	Bilateral Contract Model	Pooled Bilateral Opco Model	Poolco Model
Cost Shifting Between Entities	Possibly, Depends on Rate Design	No	No
Power Price & Transparency	Specified in Contract	Limited Spot Price Published	Spot Price Published
Transmission Price & Transparency	Utility Specific FERC Filed	Single Methodology FERC Filed	Single Methodology FERC Filed
FERC/State Jurisdiction	FERC or Disputed	FERC or Disputed	FERC or Disputed
Investment Incentive a. Generation b. Transmission	Market Negotiated	Market Congestion Cost	Market Congestion Cost
New Support Systems Needed	+ Econ Dispatch + Price Settlement + Contract Tracking	+ Econ Dispatch + Price Settlement + Contract Tracking	+ Econ Dispatch + Price Settlement
Accomodate Existing Contracts	Yes	Yes	Yes